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# Description

# [SOLDER COMPOSITION]

## CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority benefit of Taiwan application serial no. 92121256, filed August 4, 2003.

## BACKGROUND OF INVENTION

[0002] Field of the Invention

[0003] The present invention generally relates to a solder composition. More particularly, the present invention relates to a solder composition adapted to bond various materials.

[0004] Description of Related Art

[0005] Solder is a metal composition used for mechanically bonding two same metallic materials or two different metallic materials under low temperature. Soldering technique has advantages of high conductivity, high thermal diffusivity and high bonding reliability so that it has been widely used in the assembly of semiconductors and elec-

tronic components packaging as well.

[0006] Conventionally, the solder is composed of tin (Sn) and other metal to form a binary alloy such as Sn-Pb alloy, Sn-Ag alloy, Sn-In alloy or Sn-Ag-Cu alloy. These solders have been widely used to bond solderable metal articles. However, when bonding non-solderable materials or non-metallic materials, a metal pad layer must be first formed on these materials. The metal pad layer usually includes an adhesive layer such as Ti or Cr and a solderable metal layer such as Cu or Ni.

[0007] In currently semiconductor processes, bonding silicon wafer, glass, silicon nitride film, silicon oxide film or heat diffusion material is usually performed. It is noted that during reflowing, a flux is usually required for cleaning oxide layer on surfaces of the solder and enhancing the wettability of the bonded materials. However, flux residues and voids that are formed on the solder after removing the oxide layer may result in low bonding strength.

[0008] In order to resolve the foregoing problem, a conventional method is adding titanium (Ti) into the solder to form an active solder. This active solder has higher bonding strength for non-metallic materials or non-solderable

materials. However, the surface of this active solder is very easy to oxidize and generate oxidation dross, and thus has poor printability. Moreover, when using this active solder for performing bonding process, additional mechanical activation steps such as brushing step, vibration step and ultrasonic pressure step are needed to improve printability and reactivity. Since this bonding process needs several additional steps, the cost of this bonding process is high.

## SUMMARY OF INVENTION

[0009] Accordingly, the present invention is directed to a solder composition adapted to bond metallic materials and non-metallic materials. The solder composition can enhance the bonding strength for various metallic materials and non-metallic materials.

[0010] According to an embodiment of the present invention, a solder composition is provided. The solder composition comprises chromium (Cr) in an amount of 5~20 wt.%; a component selected from a group consisting of tin (Sn), zinc (Zn), bismuth (Bi), indium (In) and mixture thereof; and an impurity.

[0011] According to another embodiment of the present invention, the solder composition further comprises another

component selected from a IVB group in the periodic table or a mixture thereof having an amount of 0.01~10 wt.%

[0012] According to another embodiment of the present invention, the solder composition further comprises another component selected from a VB group in the periodic table or a mixture thereof having an amount of 0.01~10 wt.%

[0013] According to another embodiment of the present invention, the solder composition further comprises another component selected from a IIIB group in the periodic table or a mixture thereof in an amount of 0.01~20 wt.%. The metal selected from the IIIB group or a mixture thereof at least comprises cerium (Ce), samarium (Sm), neodymium (Nd), lutetium (Lu) or a mixture thereof.

[0014] According to another embodiment of the present invention, the solder composition further comprises another component selected from silver (Ag), copper (Cu) or a mixture thereof in an amount of 0.01~10 wt.%.

[0015] According to another embodiment of the present invention, the solder composition further comprises stibium (Sb) having an amount of 0.01~50 wt.%.

[0016] According to another embodiment of the present invention, the solder composition further comprises another component selected from nickel (Ni), cobalt (Co), man-

ganese (Mn) or a mixture thereof in an amount of 0.01~5 wt.%.

[0017] According to another embodiment of the present invention, the solder composition further comprises gallium (Ga) in an amount of 0.01~10 wt.%.

[0018] The present invention also provides a solder composition comprising chromium (Cr) in an amount of 0.01~5 wt.%; a component selected from a group consisting of tin (Sn), zinc (Zn), bismuth (Bi), indium (In) and mixture thereof; and an impurity

[0019] According to an embodiment of the present invention, the solder composition further comprises another component selected from silver (Ag), copper (Cu) or a mixture thereof in an amount of 0.01~10 wt.%

[0020] According to another embodiment of the present invention, the solder composition further comprises stibium (Sb) in an amount of 0.01~50 wt.%.

[0021] According to another embodiment of the present invention, the solder composition further comprises another component selected from nickel (Ni), cobalt (Co), manganese (Mn) or a mixture thereof in an amount of 0.01~5 wt.%.

[0022] According to another embodiment of the present inven-

tion, the solder composition further comprises gallium (Ga) having an amount of 0.01~10 wt.%.

[0023] The main component of the solder composition of the present invention is chromium (Cr) that has higher affinity with oxygen. Chromium (Cr) can easily combine oxygen of oxide layer on glass, metal or semiconductor materials so as to enhance the wettability of the boned materials. It also can reduce surface energy between the solder composition and the bonded materials at melting state. In addition, IIIB group, VB group, IVB group and other metal component such as silver (Ag), copper (Cu), stibium (Sb), nickel (Ni), cobalt (Co), manganese (Mn) and gallium (Ga) can be further added into the solder composition to regulate the solder composition property such as bonding strength and melting point. The solder composition can provide good printability, wide use, simple bonding process and high bonding strength for different materials.

[0024] Both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

[0025] It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of

the invention as claimed.

## Detailed Description

[0026] First Embodiment

[0027] Two solder compositions are described in the invention. According to a first embodiment, a first solder composition comprises chromium (Cr) in an amount of 5~20 wt.%; a component selected from a group consisting of tin (Sn), zinc (Zn), bismuth (Bi), indium (In) and mixture thereof; and an impurity that can not be avoided.

[0028] In a embodiment, the solder composition further comprises another component selected from the IVB group in the periodic table or a mixture thereof having an amount of 0.01~10 wt.%. In another embodiment, the solder composition further comprises another component selected from the VB group in the periodic table or a mixture thereof having an amount of 0.01~10 wt.%. In another embodiment, the solder composition further comprises another component selected from the IIIB group in the periodic table or a mixture thereof in an amount of 0.01~20 wt.%. The metal selected from the IIIB group or a mixture thereof at least comprises cerium (Ce), samarium (Sm), neodymium (Nd), lutetium (Lu) or a mixture thereof. In

another embodiment, the solder composition further comprises another component selected from silver (Ag), copper (Cu) or a mixture thereof in an amount of 0.01~10 wt.%. In another embodiment, the solder composition further comprises stibium (Sb) in an amount of 0.01~50 wt.%. Inanother embodiment, the solder composition further comprises another component selected from nickel (Ni), cobalt (Co), manganese (Mn) or a mixture thereof in an amount of 0.01~5 wt.%. In another embodiment, the solder composition further comprises gallium (Ga) in an amount of 0.01~10 wt.%.

[0029] Second Embodiment

[0030] According to a second embodiment, a second solder composition comprises chromium (Cr) in an amount of 0.01~5 wt.%; a component selected a group consisting of tin (Sn), zinc (Zn), bismuth (Bi), indium (In) and mixture thereof; and an impurity that can not be avoided.

[0031] In an embodiment, the solder composition further comprises another component selected from silver (Ag), copper (Cu) or a mixture thereof in an amount of 0.01~10 wt.%. In another embodiment, the solder composition further comprises stibium (Sb) in an amount of 0.01~50 wt.%. In another embodiment, the solder composition fur-

ther comprises another component selected from nickel (Ni), cobalt (Co), manganese (Mn) or a mixture thereof in an amount of 0.01~5 wt.%. In another embodiment, the solder composition further comprises gallium (Ga) in an amount of 0.01~10 wt.%.

[0032] The bonding temperature of the solder composition is about between 100~550°C, for example. If the solder composition mainly contains Zn-Cr alloy, the bonding temperature thereof is about between 400~700°C, for example, and can be suitable for high temperature bonding process.

[0033] When the solder composition is heated at melting state, chromium (Cr) atoms in the solder composition have an affinity with oxygen. These chromium (Cr) atoms collect at the surface of the solder and react with oxide or oxide layer on the bonded materials. Other metal atoms in the solder composition also join the reaction so that the surface energy between the solder composition and the bonded materials is changed. In addition, silver (Ag) in the solder composition can reduce surface tension and bonding temperature of the solder composition at its melting state and can enhance bonding strength after bonding. Copper (Cu) in the solder composition can enhance wetta-

bility especially for bonded materials containing iron. Copper (Cu) can also enhance bonding strength after bonding. Gallium (Ga) in the solder composition is contributive to clean oxide layer on the bonded materials and can reduce the bonding temperature. Stibium (Sb), nickel (Ni), cobalt (Co) or manganese (Mn) in the solder composition not only regulates the bonding temperature, but also enhances wettability of the solder composition and can enhance bonding strength after bonding.

[0034] No flux is needed when using the solder composition to bond materials. The solder composition can bond metallic materials, non-metallic materials, oxygen-containing ceramic materials, ceramic materials free of oxygen or polymer materials, for example. The metallic materials include, for example, aluminium (Al), copper (Cu), iron (Fe), stainless steel, nickel (Ni) and alloy-phosphorous alloy (Ni-Px). The non-metallic materials include, for example, nitride, silicon (Si), glass and semiconductor material of IIIB group, IVB group or VB group in the periodic table.

[0035] In the solder composition of the invention, conventional titanium (Ti) is replaced with chromium (Cr) as an active component so that metal element of IIIB group in the periodic table is not necessary to protect the active compo-

nent from contacting with oxygen in the air. The solder composition can be used to bond materials in oxygen-exiting conditions. Vacuum condition or other special condition is not needed so that process of bonding material through the solder composition is simplified. In other words, when performing the bonding process, only simple steps are needed.

[0036] In an embodiment, the solder composition mainly comprises tin-chromium (Sn-Cr) alloy, and other metal such as silver (Ag), copper (Cu), stibium (Sb), nickel (Ni), cobalt (Co), manganese (Mn), gallium (Ga) or a mixture thereof that is for regulating the solder property can further be added, so that the solder composition can be used to bond various materials. Comparing with conventional tin-titanium (Sn-Ti) alloy, the solder composition can provide good printability, smooth surfaces and not easy to be oxidized. The solder composition can also provide low bonding temperature, high bonding strength and wide use.

[0037] It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and

variations of this invention provided they fall within the scope of the following claims and their equivalents.